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118. Proposed by **J. W. YOUNG**, Oliver Graduate Student, Cornell University, Ithaca, N. Y.

Find the differential equations of the system of parabolas, $y^2=4a^2(x+a^2)$, and of its orthogonal trajectories, and interpret the result. Find also the equation of the system of trajectories.

Solution by **J. SCHEFFER**, A. M., Hagerstown, Md.

Since it makes no difference whether we have a^2 or a, we use the equation $y^2=4a(x+a)$. The equation of the orthogonal trajectory is, since $dy/dx=2a/y$, $1+\frac{2a}{y}.\frac{dy}{dx}=0$. Since a is variable, we must eliminate it. From the equation of the curve we find $a=-\frac{1}{2}x\pm\frac{1}{2}\sqrt{(x^2+y^2)}$, and substituting this, we have $ydx-xdy\pm dy\sqrt{(x^2+y^2)}=0$.

This being a homogeneous equation, we put $x=vy$, and since $dx=vdy+ydv$, we have $\pm\frac{dv}{\sqrt{(1+v^2)}}+\frac{dy}{y}=0$.

$\therefore\ \pm\log[v+\sqrt{(1+v^2)}]+\log y=\text{constant}$, or, taking the upper sign, $y[v+\sqrt{(1+v^2)}]=c$, or $x+\sqrt{(x^2+y^2)}=c$.

Transposing x and squaring we find $y^2=c(c-2x)$. If we take the lower sign, we find $y^2=c(c+2x)$. In either case the equation is that of a parabola of the same form as the given one. The system of the trajectories is self-orthagonal. In fact, it can be easily shown that a system of confocal conics is self-orthogonal.

Also solved by *G. B. M. ZERR.*

MECHANICS.

122. Proposed by **B. F. FINKEL**, A.M., M.Sc., Professor of Mathematics and Physics, Drury College, Springfield, Mo.

Prove that pressure P applied uniformly to a solid in all directions will reduce its dimensions along three perpendicular axes in ratio $1:1+p-2q$, p being the elongation along one face and q the contraction along the other. [Barker's *Physics*.]

I. Solution by **G. B. M. ZERR**, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

Let E=Young's Modulus, η=the ratio of the contractions (parallel to two axes) to the elongation (parallel to the third axis), e=elongation, l=reduced length of one of the perpendicular axes. Then $l(1+e)$ is the original length.

But e is composed of first the elongation parallel to the one axis$=P/E$, and the contraction parallel to the other two axes, each$=\eta P/E$.

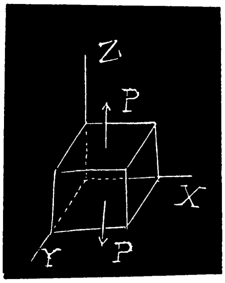
$\therefore\ e=(1-2\eta)\ P/E=p-2q$ in the problem.

$\therefore\ l:l(1+e)=l:l(1+p-2q)=1:1+p-2q$.

(See Analysis of Strains and Stresses, *Minchin's Statics.*)

II **Solution by LON. C. WALKER, A. M.**

Let the figure represent a cube whose edge is unity. If a longitudinal stress P be applied along the z-axis let the increase in length be p and the accompanying decrease along both the x-axis and the y-axis be q. The dimensions of the solid would now be $1+p$, $1-q$, and $1-q$.



Now apply three longitudinal stresses of compression, one along each of the x, y, z axes. The dimensions of the solid will now become

$$1-p+2q,\ 1-p+2q, \text{ and } 1-p+2q\ldots\ (A).$$

These three equal longitudinal stresses constitute a simple hydrostatic stress. Apply a stress of compression along one axis, and a stress of tension along an axis at right angles. Then the dimensions of the solid become $1+p+q$, $1-p-q$, and $1+p-q$.

Such a stress is called shearing stress, and the strain is$=\frac{2(p+q)}{1}$.

From the definition of Moduli we have—

(1). Bulk Modulus$=k=\frac{P/1}{3(p-2q)/1}=\frac{P}{3(p-2q)}$.

(2). Rigidity Modulus$=n=\frac{P/1}{2(p+q)/1}=\frac{P}{2(p+q)}$.

(3). Young's Modulus$=M=\frac{P/1}{p/1}=\frac{P}{p}$.

Now if p and q be eliminated from these three equations, there results $M=\frac{9kn}{n+3k}$.

From (A), if the dimensions of the cube decrease to $1-p+2q$, the ratio of decrease is $1:1+p-2q$.

[See the subject "Young's Modulus" in Dr. P. G. Tait's *Properties of Matter*, and the sections of reference in the same book.

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PROBLEMS FOR SOLUTION.

ARITHMETIC.

150. **Proposed by F. P. MATZ, Sc. D., Ph. D., Professor of Mathematics and Astronomy in Defiance College, Defiance, Ohio.**

A commission merchant sold \$$W$,=\$4750 worth of wheat. After deducting his commission at $m\%$,=3%, purchased with the proceeds a draft at d,=60 days at $r\%$,=10%, interest, and at $p\%$,=¾% premium. What was the face of the draft?